

Biochemistry

with Dr Nathaniel Boyer

Talking points

KNOWLEDGE

1. When were synthetic nitrogen fertilisers invented?
2. What percentage of the global population depends on the increase in crop yield that results from nitrogen fertilisers?

COMPREHENSION

3. As nitrogen makes up 78% of the atmosphere, why do farmers need extra nitrogen in fertilisers?
4. In what ways are synthetic nitrogen fertilisers damaging to the environment?
5. What is the difference between most diazotrophs and free-living diazotrophs?
6. How does the nodule help BNF in the symbiosis between diazotrophs and legumes?

ANALYSIS

7. How does the NifL protein inhibit the activity of NifA?
8. What was Nate's biggest finding during his research project, and why was this barrier so difficult to overcome?
9. How is the relationship between legumes and diazotrophs a symbiotic one? What benefits do they each receive?

Evaluation

10. "By supplementing the use of synthetic nitrogen fertilisers with engineered biofertilisers, the long-term impact of this work will be to increase agricultural sustainability," says Nate. Why do you think Nate plans to use the engineered biofertilisers as a supplement, instead of a replacement?
11. Nate cites the following as bad pieces of advice he has been given in the past:
"Drop philosophy – you'll never use it."
"Give the problem time – it'll figure itself out."
Why do you think he found this advice unhelpful? To what extent do you agree with him, and why?

Activities

1. In some countries around the world, such as New Zealand, there is a legal limit on how much synthetic nitrogen fertiliser farmers can spread on their land per year. Sri Lanka also banned synthetic fertilisers completely, before later revoking the decision.

Mind map the consequences of imposing a limit like this. Why might governments push for or against this?

- On the one hand, how do you think it might affect the environment? Think about the ways in which fertilisers impact surrounding areas and how the deterioration of these places might affect people too. Which groups of people do you think would support reducing fertilisers?
- On the other hand, how do you think limiting fertilisers might affect the farmer's crop yield? Think about the social impacts that a ban on fertiliser might have on a farmer's livelihood. To what extent do you think a ban could have economic impacts too, such as increasing food prices? How could this lead to other impacts?

If possible, get in touch with an environmental group in your area and ask them for their views on nitrogen fertilisers. Reach out to an agricultural group too, or to local farmers, and ask them for their opinion. Otherwise, ask your friends or family for their opinions and explanations. How are their opinions similar or different? Are any priorities in common between people on either side of the debate?

Afterwards, think about your own views on limiting fertilisers. Has your research swayed your views in either direction?

2. If you can, have a look to see how fertilisers work yourself. Buy some seeds and fertiliser from your nearest garden store. If this is not possible, ask your teacher whether you could do something similar to this activity in class, using school resources:

- Fill two plant pots with soil, but only add fertiliser to one of them. (Though it is not always clear, most commercially bought soil already has fertiliser added to it, which is not what you want! So, if you can, take some soil from a garden area or search for potting soil that specifically says it does not contain fertiliser. Or, you could use sand if you do not have any soil.)
- Plant seeds in each, cover them with more soil, and give them equal amounts of water, light and attention.
- Monitor your plants regularly to see how they compare.

Do you think the fertiliser was helpful? If you have your own garden or farm in the future, would you want to use fertiliser? Why or why not?

More resources

- Nate did an internship at a company called Pivot Bio, which makes biofertilisers based on the same principle as his research. Watch the two-minute video on its home page which explains the science, and have a read of some of their blog topics: www.pivotbio.com/our-science
- Have a look at some interesting graphics which show how synthetic nitrogen fertilisers have fed the world's growing population: ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed